Modeling the Europa Pathfinder Avionics System with a Model Based Avionics Architecture Tool

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ABSTRACT

Over the years, the Jet Propulsion Laboratory (JPL) has developed a system engineering process for spacecraft development. This process includes mission conceptual development, system definition, and architecture design. While this process has been successfully applied to many flight missions, it has been costly and lengthy because it requires many human interactions in order to establish the requirements and specifications. Worse yet, the traditional textual requirements and specifications are often error prone, ambigious and sometimes contain many oversights and mistakes. With these specification problems often not realized until system intergation and testing or even during the mission itself, the re-engineering effort involved can often be extremely expensive or sometimes results in catastrophic failure of the spacecraft. Therefore, JPL has initiated a series of efforts to develop a set of system engineering tools to improve the process. One of these tools is the Avionics System Architecture Tool (ASAT).

ASAT utilizes a standardized multi layer interface, communications protocol, infrastructure support functionality, architecture configuration file, and scenario files to drive architecture simulations. The standard interface and protocol allow the user to initially ignore explicit interface details of connecting components, and thus allowing users to quickly build up multiple architecture options for trade-off studies. The standard interface can be broken down into three interface layers: the Core, Implementation, and ASAT layers. The core layer represents the component's core functionality. For example, if a component was representing a PCI bus, the core would represent the dynamic behaviors, protocols, timig, etc that are associated with that bus. The implementation layer describes some non-standard details that might be different from system to system. The implementation layer is necessary for building a complete architecture model for simulation. However, at the early phase of the system design, it is only an approximation of the actual hardware. As the system design matures, the details in the implemention layer can be replaced by more accurate description of the hardware. Finally, to facilitate a component plug-and-play architectural modelling environment with rapid design trades allowable, every component interfaces through the ASAT layer. This layer describes a communication protocol that is representative of many typical interfaces.

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ASAT has recently been applied to model the avionics architectures of the Europa Pathfinder mission study project. The Europa Pathfinder avionics system consists of a rad-hard Power PC 603e processor, a surface imager, a Raman spectrometer, a laser induced backscatter spectrometer, a micro-seismometer, 3-axis accelerometer that are connected by a high speed (3.4 Mbps) I2C bus. In addition, the processor has a separate I2C bus connected to an UHF transponder. ASAT has modeled the inter-subsystem commnunication of this

architecture and observed that the high speed I2C in the original architecture was significantly under-utlized. That observation inspired an augmentation to the original architecture, which uses a fast (400 kbps) I2C instead of the high speed I2C bus. However, in the augmented architecture, it is observed that the bus can be monopolized by a single subsystem unless a TDMA approach is used to control the bus traffice. These observations and inspirations were achieved in a much shorter time than the traditional system engineering approach at JPL. Futhermore, due to the plugand-play environment of the ASAT, the model was created in less than three weeks and the augmentations were done in less than one day.